

THE DUSTFALL OF NOVEMBER 12-13, 1933

By ERIC R. MILLER

[Weather Bureau, Madison, Wis., February 1934]

Meteorological observations are now so numerous, on account of the development of the weather service along airways, and the addition of upper-air observations with pilot balloons and airplanes, that it is possible to fix the origin of the Buffalo dustfall of November 13, 1933, with a high approach to certainty.

The state of the atmosphere at the time the dust was precipitated at Buffalo is shown graphically on the weather map, figure 2, November 13, 8 a.m., prepared from simultaneous observations throughout the United States and Canada. This map was very kindly furnished by Mr. John Patterson, Director of the Canadian Meteorological Service, who has added the track of the center of the cyclone that then occupied the region just west of the Appalachian Range from Quebec to the East Gulf States.

The important feature of this map is the wide-spread northwest wind, extending from the wind-shift line westward to the plains. It was the underrunning by this wind of the southwest wind, shown along the Atlantic seaboard, but previously occupying the region west of the mountains, that produced the fall of rain and snow (shown by horizontal hatchures) that brought down the dust.

Figure 1, November 12 (8 a.m.), shows the atmospheric conditions just 24 hours earlier than those of figure 2. The center of the cyclone was then near Winnipeg, the pressure gradient very steep, and the winds correspondingly strong.

The hourly airways reports show that while the winds were light to moderate in the early morning, the velocity steadily increased, and by 1:30 p.m., fierce gales with velocities of 45 to 63 miles per hour were raging over a wide area between Bismarck, N.Dak., and Kansas City, Mo., and between the Badlands of South Dakota and Sand Hills of Nebraska, and the Mississippi River where it bounds Minnesota and Iowa.

The strength of the wind was so great that not only dust was whirled up from the roads, but also gravel and pebbles, and fall-plowed fields marked by clouds of drifting soil. An airplane pilot at Omaha found the top of blowing dust only on ascending to 9,000 feet, while at the ground the air was so thick that objects 50 to 100 feet away could not be seen.

It is interesting to speculate whether the volcanic materials found at Buffalo were transported directly from Alaska, especially as this storm is shown by weather maps to have skirted along the Alaskan-Pacific coast. This, however, is negatived by reports from the weather-observing stations along the northwestern border. Pembina, Devils Lake, and Williston, N.Dak., report no dust or haze at any time on the 12th, and at Bismarck, blowing dust was reported at only 1 hour. The western and southern limits of the area of deflation are indicated by reports of no dust at Miles City and Havre, Mont., Sheridan and Cheyenne, Wyo.; for only 3 hours at Dodge City, Kans., and none at all at Wichita, Kans.

The dust cloud was carried mostly southeastward by the storm winds, but with much spreading toward the East and South. The hourly reports transmitted by teletypewriter along airways enable one to follow the progress of the dust cloud through the afternoon and night of the 12th, and in the Southeastern States on

through the whole of the 13th. Isochrones; for every fourth hour, of the front of the dust cloud, are shown in the inset in figure 2.

The wings of the dust cloud were markedly thinner than the middle. The meteorological airplane flight at Dallas, Tex., November 13, 1933, at 5 a.m., E.S.T., rose through a dusty stratum 5,500 feet thick before emerging into clear air above, and the temperature-altitude graph shows bend-points very similar to those observed at Omaha on the previous morning. The airways observer at Buffalo reported "Dark in the northwest, thick dust approaching from west" at 10:02 a.m., E.S.T., on the 13th, while at Mercer, Pa., the visibility was already down to 1 mile on account of dust at 9:42 a.m. Jamestown, N.Y., also reported dust in rain about 9 a.m. At Rochester housewives complained of muddy rain on their Monday washings hung out to dry. At Syracuse the rain-precipitated dust was afterward found on windows and automobiles.

The airways observers at Bellefonte, Pa., observed dust with mist and rain between 3:15 and 4:35 p.m., while at Watertown, N.Y., the dust cloud itself was observed to strike the town at 3:30 p.m. At Binghamton no cloud was observed, and the continuously operated air-filter paper at the laboratory of the Agfa Ansco Corporation failed to show dust. At Alexandria Bay, N.Y., the observer noted discolored rain falling at 2 p.m. In Vermont the regular observers did not note the phenomenon, but received an inquiry about "brown snow" from the eastern part of the State.

The denser middle of the dust cloud reached Tennessee early on the morning of the 13th, reducing the visibility to one quarter mile at Nashville at 8 a.m. and to one fifth mile at Chattanooga at noon. The onward drift carried the dust over Mississippi, Alabama, and Georgia during the afternoon and night of the 13th, with visibilities as low as 2 to 5 miles as late as 11 p.m.

HUMIDITY

Winds from the plateau beyond the Rocky Mountains on descending the eastern slopes of the ranges were warmed by compression and their relative humidity correspondingly decreased. The reports of the airways observers show this drying beginning early in the morning of the 12th at Denver, Cheyenne, and Sheridan. The greatest dryness, curiously enough, was not at the base of the mountains, but at Kansas City, where the relative humidity fell to 10 percent at 8 p.m. of the 12th.

This fact hints that the subsidence and heating continued as the air mass moved away from the mountains, on account of the divergence that has already been noted, the spreading of the lower layer being supplied by descent of air from above. The extraordinary dryness persisted in the dust-bearing air mass as it drifted southeastward all the way to the Atlantic. At midnight of the 12th the relative humidity was 21 percent at Wichita, 20 percent at Terre Haute; at 4 a.m. of the 13th, 28 percent at Little Rock, 30 percent at Louisville; at 8 a.m., 36 percent at Little Rock, 54 percent at Elkins; at noon, 31 percent at Jackson, Miss., 40 percent at Mobile, 36 percent at Knoxville, 39 percent at Lewes, Del., and 53 percent at Savannah, Ga., and Wilmington, N.C.

Figure 1. Weather Map, 8 a. m., November 12, 1933, when dust was blowing up from the ground on the northern Great Plains

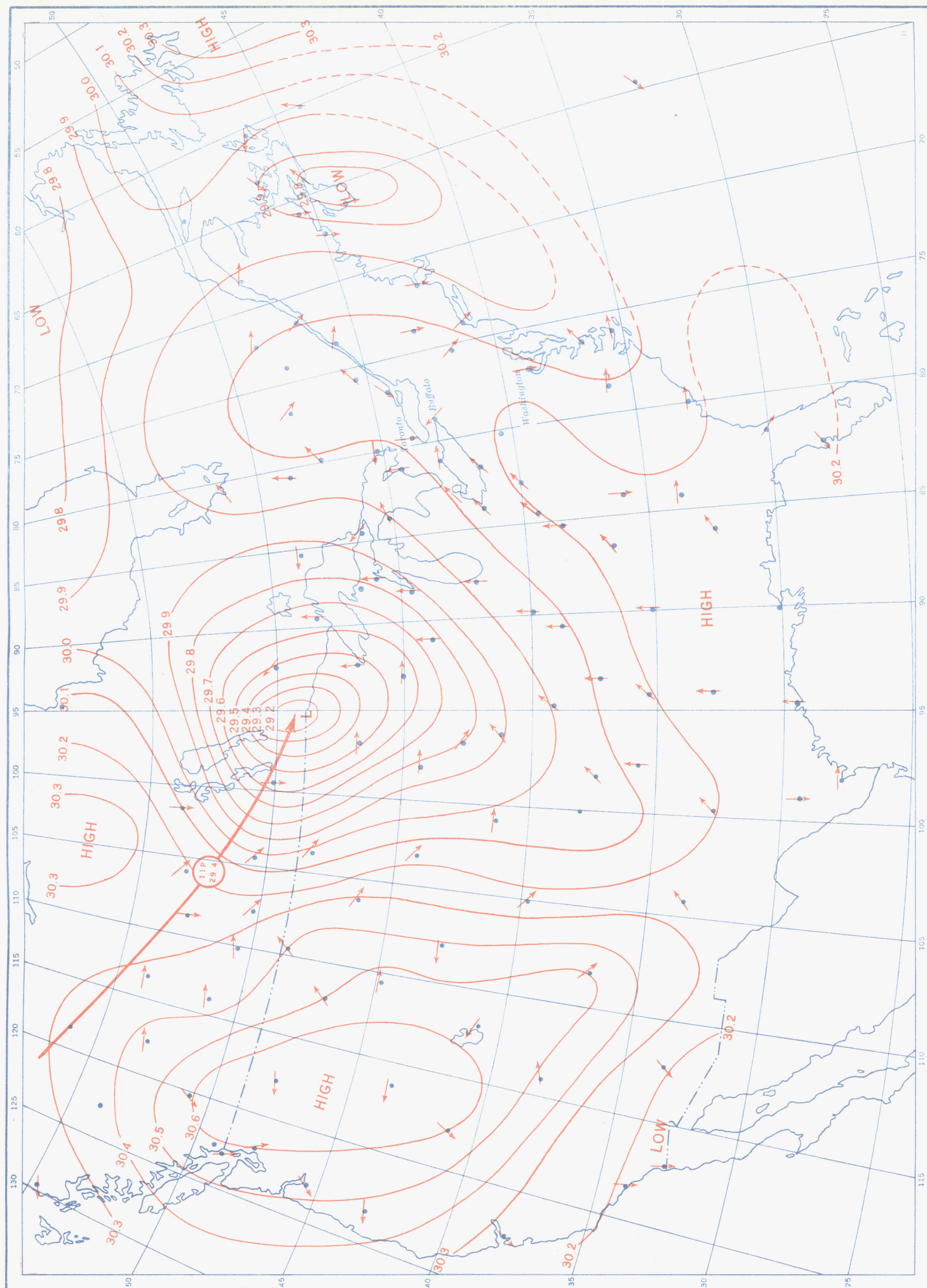
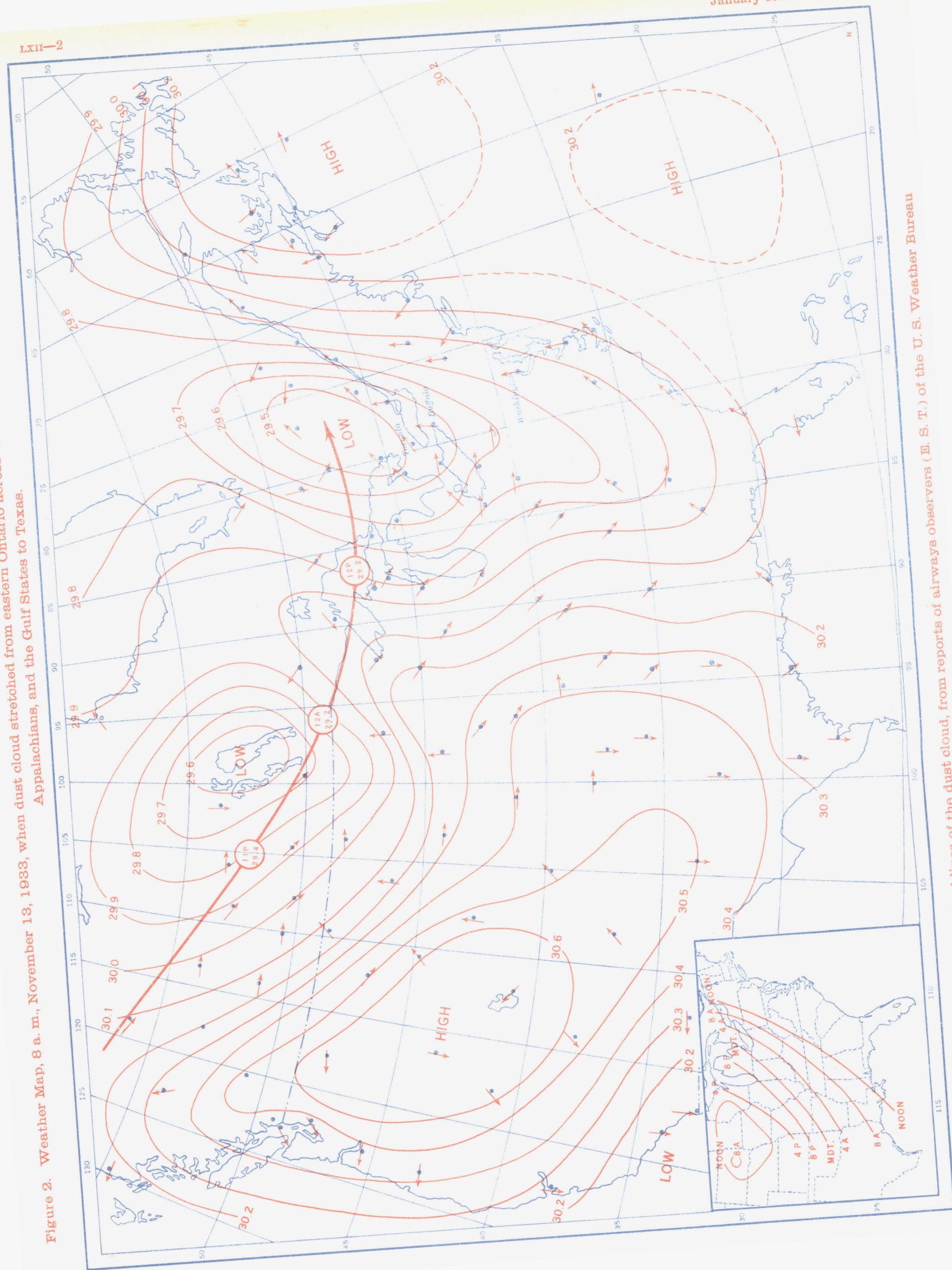


Figure 2. Weather Map, 8 a. m., November 13, 1933, when dust cloud stretched from eastern Ontario across western New York, the Ohio Valley, the southern Appalachians, and the Gulf States to Texas.



January 1934. M.W.R.

(Inset) Isochronal lines of the dust cloud, from reports of airways observers (E. S. T.) of the U. S. Weather Bureau

COLLECTION AND EXAMINATION OF DUST

Wind-borne dusts are of interest to geologists for the light they throw on the rate of deposition of loess, and on the character of minerals supposed to be of aeolian origin. For the solution of these problems it is desirable to know the quantity of dust precipitated per unit area, especially in rain and snow, and the relative quantity of different sizes. The best plan for making this determination is to measure off a square yard or square meter, and brush up the dust, if dry, or to shovel up all the dust-bearing layer of snow or sleet. Rain with dust is best taken from the ordinary Weather Bureau rain gage.

To determine the soluble materials in a dustfall, and these are important in estimating how fast potassium and other natural fertilizers are being added to eastern soils by air transport from the arid West, it is essential not to filter the rain and melted snow, but to evaporate them.

The samples collected for weighing and sizing, will also serve for mineralogical and chemical analysis, if carefully

handled. The identification of diatom tests, and other organic materials can also be made on the same material. For the detection of viable spores, it is best to notify specialists in plant pathology, so that they may go into the field before the dustfall disappears and secure uncontaminated material for incubation.

LITERATURE THAT MAY BE CONSULTED

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- (2) Twenhofel, W. H. Treatise on sedimentation. Baltimore.
- (3) Winchell & Miller. The dustfall of March 9, 1918. *Am. Jour. Sc.*, v. 46, 1918, pp. 599-609, and v. 47, 1919, pp. 133-134.
- (4) ——— The dustfalls of March, 1918. *Mo. Wea. Rev.* 1918, v. 46, pp. 502-506.
- (5) ——— The great dustfall of March 19, 1920. *Am. Jour. Sc.*, vol. 3, 1922, pp. 349-364.
- (6) ——— The dustfall of February 13, 1923. *Jour. Agr. Res.*, vol. 29, 1924, pp. 443-450.

PETROLOGY OF THE GREAT DUSTFALL OF NOVEMBER 13, 1933

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Snow falling at Buffalo on the morning of November 13, 1933, was observed to be discolored. The depth of snow on the ground, including previous falls, was about 5 inches, but in order to avoid contamination only the top few inches of fresh snow was collected. This was melted, the liquid filtered, and the residue mounted in Canada balsam, and then examined, with polarized light, with the microscope.

The organic and inorganic substances present are:

Volcanic glass	Hornblende
Quartz	Diatom tests
Feldspar	Spores
Mica	Pollen
Tourmaline	Vegetable fibers
Zircon	

There are two kinds of volcanic glass in the dust. In transmitted light, one variety is colorless and contains inclusions, which may be either liquid or gaseous. The other variety is black, and suggests basaltic glass. The feldspar is unaltered. It consists of orthoclase, microcline, and plagioclase feldspar. These mineral grains are angular to subangular in appearance. The quartz and feldspars examined from the Buffalo dustfall are glassy clear and are not at all stained by iron oxide as were those in the Madison dustfall of 1918, concerning which Winchell and Miller (1) say "both the quartz and the feldspar are stained by limonite and hematite, and this condition seems to pervade the fragments so thoroughly that it is a condition of long standing." The mica is mainly muscovite, although a green variety present probably represents some form of biotite. Brown and blue colored tourmaline are present, as is colorless zircon. Both of these minerals are distinctly euhedral.

The hornblende is light green and possesses the characteristic prismatic cleavage of the amphiboles. While most of the mineral grains present are subangular to angular, a few minute, undetermined, colorless grains, showing abnormal berlin blue interference colors under

crossed nicols suggestive of vesuvianite or zoisite, are distinctly subangular or subrounded.

Winchell and Miller (2), speaking of the Madison dustfall of 1918, state that "microscopic measurements of the size of the particles show that they range from about 0.003 mm to 0.1 mm but a surprisingly large percentage falls within much narrower limits, namely, 0.008 to 0.025 mm." The range of the diameters or lengths of the Buffalo dust particles varies from 0.005 to 0.5 mm, while a large percentage of the dust averages 0.02 mm. A little of the dust was spread out on a black sheet of paper and it was seen that a few colorless grains were just large enough to be visible to the naked eye.

About 10 percent of the entire sample consists of organic matter. According to Mrs. Imogene Robertson, assistant curator of biology at the Buffalo Museum of Science, the organic matter consists of spores of microfungi, ferns, mosses, and encysted protozoans. The spores seen present a variety of forms and shapes. Some are spherical, others ovoid, still others distinctly elongated. These varishaped spores are some smooth, some pitted, and a few distinctly spinous.

According to Winchell and Miller, the Madison, 1918, dustfall consists mainly of feldspar, quartz, and diatom tests, with minor amounts of other constituents, and Twenhofel (3) suggests that the place of origin was the semiarid regions of New Mexico, Arizona, and adjacent States. The assemblage of organic and inorganic matter which composes the Buffalo grit, however, is characteristic for the most part of dried-up playa lakes and ponds or flood-plain areas.

REFERENCES

- (1) Winchell and Miller, The dustfall of March 9, 1918. *Am. Jour. Sc.*, v. 46, 1918, pp. 599-609, and v. 47, 1919, pp. 133-134.
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- (3) Twenhofel, W. H., Treatise on sedimentation, Baltimore, 1932, p. 68.